

PATENT  
Serial No. 09/918,831  
Amendment in Reply to Final Office Action of August 23, 2005

IN THE SPECIFICATION

Please amend the specification as follows:

Replace the paragraph spanning pages 1-2 between page 1, line 20, and page 2, line 8 of the specification with the following:

A well-known example of a Feistel cipher is DES, consisting of sixteen rounds. In each round, first the 32 bits of the right half of the data are expanded to 48 bits. Next, ~~an~~a 48 bit round key, which is computed from a 56 bit DES key with a key scheduling algorithm, is bit-wise added modulo two to these 48 bits. Then a layer of S-boxes performs a non-linear operation on the data. In DES, the S-box layer consist of eight six-to-four bit S-boxes in parallel, i.e. each of the S-boxes converts a 6-bit input block into a 4-bit output block using one fixed mapping table per S-box. The output of the S-box layer is a 32 bit data block. The linear transformation, which is performed on this 32 bit data block, is a bit-permutation, which ensures that bit changes caused by an S-box are propagated over many other ones in the following round(s). A drawback of DES is its small key size of 56 bits, which is

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considered to be insufficient nowadays for offering a high level of security. However, an exhaustive key search can be avoided by using a longer key combined with a different key scheduling algorithm for computing the sixteen 48-bit round keys. The two most powerful attacks on DES published in the open literature are differential and linear cryptanalysis, which are general attacks that can be applied to a wide range of block ciphers. It has been shown that DES can not be strengthened much against these attacks by modifying the key length and/or the key-scheduling algorithm. However, changes in the round function of the algorithm can influence its strength against these attacks considerably.

Replace the paragraph on page 3, between lines 1-2 of the specification with the following:

~~As defined in the measure of the dependent claim 2, the~~  
The new columns can be (pseudo-)randomly generated in order to find suitable columns.

Replace the paragraph on page 3, between lines 3-10 of the specification with the following:

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~~As defined in the measure of the dependent claim 3, the~~ The  
resulting matrix C is permuted to find a linear transformation  
matrix with the associated linear error-correcting code having a  
predetermined multi-bit weight. ~~As defined in the measure of the~~  
~~dependent claim 4, this~~ This multi-bit weight ensures proper  
diffusion over the S-boxes of the cipher. For instance, for an S-  
box layer consisting of a number of S-boxes operating in parallel,  
in which each S-box provides an m-bit output, it is relevant to  
look at the diffusion of m-bit parts of the words in the associated  
binary error-correcting code, which can be expressed in the minimum  
m-bit weight over all non-zero codewords.

Replace the paragraph on page 10, between lines 3-16 of the  
specification with the following:

Due to the construction of the round function with the multi-  
bit S-boxes, also good diffusion properties on this multi-bit level  
are desirable. For four-bit S-boxes, this can be expressed as  
follows (variations for other number of bits fall well within the  
skills of persons skilled in the art). If the 4-bit vectors  $n_i$  ( $i =$   
 $0, 1, \dots, 7$ ) of a codeword  $c \in \mathbb{Z}_2^{32}$  are defined as  $c = (n_0 \parallel n_1 \parallel$

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...  $|| n_7)$  then the nibble weight of  $c$  is defined as  $NW(c) := \#\{ i$   
 $|| n_i \neq (0,0,0,0), i = 0,1, \dots, 7) \}$ . The diffusion properties on  
nibble-level can be expressed in terms of the minimum nibble weight  
over all non-zero codewords; the higher this minimum weight, the  
better the diffusion properties on nibble-level. To achieve a high  
diffusion at multi-bit level (in the example, at nibble level), in  
step 530, two permutation matrices  $P_1, P_2 \in Z_2^{32 \times 32}$  are selected (in  
step 532) such that all codewords in the  $[64,32,12]$  code with  
generator matrix  $( I || P_1 C P_2 )$  have a high nibble weight, as  
verified in step 534. The finally found matrix  $A := P_1 C P_2$  is used  
for the linear transformation. In a preferred embodiment, the  
permutation matrices  $P_1$  and  $P_2$  are (pseudo-) randomly generated. It  
can be verified in step 536 that the minimum nibble weight of the  
code generated by  $( I || A )$  equals seven.